Hi Carol,
Thanks for your help with this.
Any corrections or suggestions, especially on pp. 6-18, would be greatly appreciated.
Best,
Bob

Mining's Legacy:

The Ontology of an Environmental Controversy

It is only in recent times that thinkers have become aware of the difficulty of finding a beginning in philosophy....

G.W.F. Hegel, *The Science of Logic* (1831)

As a student of the history of culture, Hegel recognized that European civilization had entered an era characterized by *difference*. A newly awakened sense of history, exposure to different cultures around the world, and the rising tide of democracy had led people to question the common set of assumptions that had formed the background to public conversation. Abandoning a common ground and vocabulary, patterns of thought now evolved in isolation from others within the community. In this climate the question of how one *begins* thinking assumed paramount importance. For as Hegel saw, the places from which thinking begins largely determines the characteristics of that thinking.

This essay argues that the abortive quality of our environmental debates results from the obscurity of the origins of our thinking. We talk at cross-purposes, because we have lost sight of the roots of our own and other's thought. We have lost the vocabulary for expressing those matters that most deeply concern us. Our most fundamental reactions to environmental issues have been made marginal by a public conversation that is still positivist in its assumptions.

Today the differentiation and fragmentation of community witnessed by Hegel has accelerated tremendously. Space and time, the very parameters of our lives, have been transformed. As we become members of a global economy, linked by instantaneous communication, we also withdraw from those who share our geographical space, forming virtual communities across cyberspace. The very idea of community—and of nationhood—has become an anachronism, as a person in Denver shares more interests with someone in Florida or Berlin than with their next-door neighbor.

In such circumstances a nuanced account of the origins of our thinking—environmental or otherwise—becomes crucial. Tracing out the varying sources of our thinking can show the way toward the resolution of the environmental controversies we face.

1. Introduction

These are good times to be an environmentalist. The American environmental movement has been remarkably successful. The nation's air and water are cleaner than 20 years ago, and a few high-profile species have rebounded from the brink of extinction. Attitudes and habits that were once marginal are now mainstream: recycling programs are ubiquitous, and the preservation of open space is becoming common nationwide. A majority of Americans even support the preserving or strengthening of environmental regulations, even if it requires an increase in taxes.[1]

One may nonetheless wonder whether our successes have been limited to those issues easiest to resolve. The hard cases may still lie before us, as we turn to environmental matters that provoke radically different and irreconcilable responses from people. Indeed, the most striking feature of our environmental conversations today is the incoherent nature of most debates. This is true whether the controversy is the restoration of salmon in the Northwest, the burial of the nation's high-level radioactive waste at Yucca Mountain in Nevada, or the resurrection of the Everglades ecosystem in Florida.

Beginning from different places, individuals and groups marshal different sets of facts (or reject the relevance of facts), rely upon different kinds of experts (or deny the possibility of expertise), and appeal to different standards of evidence. Not surprisingly, such discussions often resemble ships passing in the night. Misunderstanding leads to endless debate, and frustration encourages the demonizing of one's adversaries. The public sphere, the realm of common conversation, turns sour. People become alienated from the political process, and come to view government as a distant and hostile entity. Often the result is public policy paralysis, and finally litigation, as contestants turn to the courts to resolve their differences.

One must, of course, acknowledge that much of this breakdown in communication is intentional. On all sides individuals remain wedded to their views beyond all reason and fairness. The role that self-regard—or more simply, human venality—plays in such discussions is undeniable. These melancholy facts are unlikely to change, however, and any environmentalism that is based upon a reformation of human nature faces a decidedly uphill struggle. Nonetheless, all is not lost. Real progress toward the resolution of our environmental conflicts is still possible—if we can find the means for better communication between people coming from different interests and perspectives.

In claiming that the improvement of our environmental debates turns on bettering the means for communication, I am not suggesting that we should hire more experts in mediation and conflict resolution. I do not wish to give offense to my friends in these fields, for such professionals have a vital role to play in the resolution of environmental issues. But the roots of our problem are to be found in our philosophic assumptions rather than in our techniques of mediation. We are the unconscious victims of epistemological assumptions that thwart conversation. Once we expose these assumptions we find that the conversation turns toward subjects that are seldom explicitly raised in environmental debates—questions of metaphysics, aesthetics, and theology.

It is our silence on these latter topics that renders so much of our conversation pointless or counterproductive. Or more precisely: our inability to integrate science and economics with our metaphysical, aesthetic, and theological concerns stymies serious discussion. For it is not only the claims of others that we misunderstand. We also look past our own deepest motivations, translating our concerns into language thought to be acceptable for public debate.

In what follows I will ground these claims—bringing philosophy down to earth—through the examination of the controversies surrounding acid mine drainage on abandoned mine lands in the San Juan Mountains of southwest Colorado. Acid mine drainage is a problem of national and global importance, but it has particular resonance in the West, where there are hundreds of thousands of abandoned mines, and thousands of miles of streams contaminated by low pH and high metal content.[2] The question of restoring these areas—to what standard, and at whose cost—has sparked intense debate. The size of the national problem is enormous: one estimate puts the total cleanup at between 32 and 72 billion.[3] Parties to this dispute include land owners and local officials, environmental organizations and mining companies, lawyers, government scientists, tourists, and shopkeepers. The acid mine drainage debate will provide us with a microcosm of the difficulties we face throughout our environmental controversies, as well as to more general debates found throughout our society.

To understand the issues surrounding acid mine drainage requires that we draw upon a wide variety of information, including history, sociology, geology, hydrology, public policy, environmental law, and political theory. Surrounding and mingling with all of this information are the perspectives and concerns of aesthetics, ethics, epistemology, metaphysics, and theology. The radically interdisciplinary nature of the acid mine drainage controversy will itself raise questions concerning the limits of knowledge and the role of the expert in resolving environmental disputes. Philosophy arises through attending to the interstices and points of contact between these various disciplines, rather than being imposed from above.

This essay uses the acid mine drainage controversy as a case study that reveals the ontological nature of our environmental problems. The term "ontology" is of Greek origin: "ontos" means being or reality, and "logos" translates as structure or order. Ontology, then, is concerned with the ways that we divide reality up into parts, and the relationship between those parts.

One of the first concerns of ontology is the question of "natural kinds." Are the divisions we perceive in the world written into the deep structure of reality, or are they to one degree or another expressions of particular historical circumstances, and thus subject to change as society changes? The disciplinary matrix of academia—the partition of the university into colleges, and colleges into the various departments—is itself a reflection of the ontological breaks we believe to have found in the world. We have broken knowledge into discrete disciplines—the arts and the sciences, poetry and geology, history and chemistry, aesthetics and political science—confident that these fields may be studied in isolation from one another. Courses in art history are not required of the earth science major, or vice versa. Neither is a course in eastern religions included as part of the major in chemistry.

These decisions seem obvious today, but I believe that the inadequacy of our public conversations is rooted in precisely these choices. The current way of defining, and dividing, the disciplines has become a serious obstacle to resolving our environmental problems.

We will turn to these ontological—and pedagogical—questions below. But first we must work through the details of our case study.

2. Acid Mine Drainage in the Upper Animas River Drainage, Colorado

Background

By the standards of the well-watered eastern US, the Animas River is not a large river. Winter flows average 1500 cfs (cubic feet per second), and spring snowmelt typically peaks in late May at 7000 cfs—numbers which translate into a stream of approximately 100 feet wide. The river's sources lie in the high reaches of the San Juan Mountains, a range of volcanic origin that rises to over fourteen thousand feet.

Beginning as snowmelt, the Animas flows through Silverton and Durango, Colorado and the Southern Ute Indian Reservation before ending in Farmington, New Mexico. There the river joins the San Juan River on a common journey to the deserts of Utah, the Colorado River, and eventually the Gulf of California (map 1). The Animas is not a commercially navigable river;[4] its main use is for irrigation, fishing, and drinking water, and increasingly in recent years as a source of whitewater recreation.

The questions concerning acid mine drainage center upon the upper Animas drainage, in the high mountains and valleys surrounding the town of Silverton (map 2). The area is a popular tourist destination, attracting visitors for hiking, backpacking, horseback-riding, four-wheel driving, whitewater rafting, and the pleasures tied to its history. The latter include a narrow-gauge railroad (narrow, because the canyons are so tight), ghost towns, and historic mines from the gold strike days of the Old West.

Southwestern Colorado has a rich history of mining.[5] The town of Silverton was center stage for a series of booms and busts that began in the mid-1870s. The current bust period dates from the closure of the Sunnyside Gold Mine in 1991. The closure of the Sunnyside was part of a nationwide eclipse of the US mining industry--the victim of declining reserves, low metal prices, environmental regulations, and changing cultural values. The U.S. Department of Labor Statistics reports that between 1980 and 1990 the energy and minerals industry in the U.S. lost 450,000 jobs *[update this?]*. The vast majority of mining today is "offshore," in countries where the costs associated with land, labor, and environmental regulations are much less.

By 1947 two million ounces of gold had been removed from the mountains surrounding Silverton [*total*?]. The miner's attentions were focused upon gold and silver, but the mountains also contained significant amounts of other metals such as copper, aluminum, iron, lead, and zinc. The latter three metals lie at the root of the current problems: when bonded with sulfur they formed pyrite, galena, and sphalerite, minerals which are the source of the acid and heavy metals that affect the Animas river system.

The town of Silverton rests at 9300 feet in a steep valley where the sun sets early much of the year. The winter population is around 350: access is gained via Highway 550, which is periodically closed in both directions by snowfall and avalanches. The population expands in the summer, with the return of absentee landowners (who come for the weather and the scenery) and the owners of trinket shops (who come for the tourists). The tourists come by car and bus, but are most commonly dropped off by the Durango and Silverton Narrow Gauge Railroad, which runs a half dozen times a day in the summer, taking three hours to cover the 46 miles from Durango.

The railroad first reached Silverton in 1882. Its presence allowed for easier transport of goods and ore, and led to the relocation of the main smelter to Durango the next year [*check*]. The train ran until 1951, then returned in 1973 as a quaint piece of the old West to mine the tourist trade [*dates*]. The route from Durango generally follows the Animas, sometimes clinging to the sides of cliffs hanging over the river. This part of the trip, known as the "Highline," is not for the faint-hearted. The railroad also passes through the Weminuche Wilderness Area, the largest wilderness area in Colorado. Backpackers sometimes catch a ride into the wilderness on the train, to be dropped off at Elk Park, to be retrieved later when they flag the train down on its return to Durango.

The veins and ore bodies today may have played out—at least until the next jump in the metals market. But the legacy of mining remains. A casual car-tour of the San Juans is enough to alert one to the possibility of controversy. Several of the streams of the upper Animas (e.g., Mineral Creek, Cement Creek) run orange, with the water, rocks, and banks stained red and covered with filamentous algae. A closer inspection reveals the absence of aquatic life, in certain sections and raises concerns about possible health effects for the residents of Silverton, as well as for people downriver in Durango, Colorado, and Aztec and Farmington, New Mexico. The region contains innumerable mining structures that still stand (or lean), and more than 400 abandoned mines. Depending on one's aesthetic and historical opinions these old mine structures, mine dumps, and tailing ponds are either picturesque or an eyesore. Today the entire town of Silverton is a National Historic Landmark, and the local economy survives on tourists interested in seeing a piece of history as well as the area's natural beauty.

Defining The Problem

Such, in outline at least, is the situation. To see the red and lifeless river courses of the upper Animas as a *problem* requires a shift in perspective. By what criteria does acid mine drainage count as a problem? What should count as a resolution? Who are the responsible parties, and who should bear the costs of correcting these problems?

One finds no clear answers to these questions. The decisions made in recent years within the Animas drainage have not been triggered by any one particular law, individual, or group. Rather, like the river itself, events flow together, combining in often unpredictable ways. Issues of law and public policy play off of individual personalities. Tradition and precedent pair off against scientific data. Supposedly objective scientific data is found to be beholden to values and assumptions. And surrounding all of this are economic realities and the primordial human responses to a landscape that embodies the history and ideals of the people who inhabit and visit this place.

This multiplicity of perspectives means that there is no one way to relate the story of acid mine drainage. Each account will frame the story in a different way, highlighting certain features while casting others into shadow. The search for the one right account is a chimera: there is no single correct, objective perspective on the acid mine drainage controversy. One searches in vain for a framework or perspective that throws a clear and unequivocal light on all perspectives.

This does not mean, however, that our only choice is to acknowledge that we are lost in the endless conflict of subjective opinions. The language of objectivity and subjectivity itself forms part of the problem, for it distorts the conversation at the outset. Human interests are always intimately intertwined with the production of knowledge, scientific or otherwise. Rather, these various accounts can contest with one another, with the possibility of a more complete explanation emerging over time from the mosaic of perspectives.

Of course, in our culture some perspectives are given clear priority over others. Claims based in economics, federal or state law, or science have a secure place within our cultural conversation, for they reflect the epistemological assumptions of the age. (Epistemology is the study of knowledge: it asks questions concerning how we know, and what counts as sufficient proof of our knowledge.) On the other hand, ethical claims are more dubious. While all of us lay claim to certain rights concerning freedom and justice, there is a deep-lying suspicion that ethical claims are fundamentally arbitrary and self-interested in nature. Other human responses to the land—those that are aesthetic, metaphysical, or theological in nature—fare even worse.

In our case, that of acid mine drainage in the upper Animas, the dominant account goes something like this. The initial impetus for correcting the effects of mining came from the enforcement of the Clean Water Act. National and local environmental organizations did not raise the alarm about acid mine drainage; neither were there significant protests by the citizens of Durango and Silverton, the two towns most liable to be affected. In fact, as we will see, local participation, in the form of the Animas River Stakeholders Group, was first organized by an outside (state) organization. Local citizens and officials were hostile to initial attempts to bring them together, and overcame their reluctance to participate only out of the fear that if they did not, state and federal agencies would simply dictate a solution from above. It was the Clean Water Act that defined the upper Animas River as a problem.

In order to understand the context of the controversies surrounding acid mine drainage, it is necessary to have a passing familiarity with some features of environmental law. These points of law provide the framework for the debate, and determine much of what happens on the ground. Of course, individual interpretations of these laws vary; and officials have been known to search for statutory justification of what he or she wanted to do, rather than their actions simply being driven by the dictates of the law. It is also true that local citizens are often able to influence, obstruct, or ignore the implementation of these policies.

In 1972, Congress enacted the Federal Water Pollution Control Act. This statute was supplemented by the Clean Water Act in 1977. Both acts, with subsequent amendments in 1981, 1987, and 1993, are commonly referred to as the "Clean Water Act" or CWA.[6] The Clean Water Act seeks to protect the nation's navigable[7] waters by setting water quality standards for surface waters, and by limiting effluent discharges into these waters throughout the United States.

The Clean Water Act's mandate called for the "restoring and maintaining of the chemical, physical, and biological integrity of the nation's waters."[8] To achieve this, it required states to establish water quality standards for every river basin in the US. The CWA also established a permit system to regulate point-source discharges (a "point-source" of pollution is a discrete, identifiable source of discharge: a pipe or a ditch, for instance; non-point sources lack a single identifiable location: for instance, agricultural and city street runoff). Polluters are issued NPDES (National Pollutant Discharge Elimination System) permits that describe the stream-specific water quality standards that their effluents must meet.

The Environmental Protection Agency has ultimate jurisdiction over enforcement of the Clean Water Act. But as a matter of policy, the EPA grants states "primacy" over the application and enforcement of the Clean Water Act to ~~more local~~ State authorities. The agency still retains an overall responsibility under the Act, can approve or disapprove all state rules and regulations, and oversees state enforcement. The EPA may also take independent action when it believes that state programs are not adequately meeting federal standards. This represents a potential dilemma for a company or municipality: having satisfied the state, the EPA may step in and take enforcement action. More commonly, however, the EPA arm-twists, threatening to take over a program until it gets the rules and regulations it wants.[9]

The 1972 Act called for the establishment of interim water quality goals throughout the nation by 1983. In response, the state of Colorado began moving toward control over the Animas drainage in 1979, when the Colorado Water Quality Control Commission (the WQCC) first established use classifications and water standards for the Animas. At that time the WQCC did not attempt to classify the upper reaches of the drainage, because so much of the upper drainage was of devoid of fish and macro-invertebrates, the result of low pH and heavy metal contamination. (This began to change in 1985, when San Juan County Commissioner Bill Simon and others started a fish stocking program, backpacking fish into streams that they thought might be able to support fish.)[10]

In 1991 the Colorado Water Quality Control Division (a different entity from the WQCC; part of the Colorado Department of Public Health and Environment, the CDPHE) began to collect water quality data in the upper Animas, a program it continued through 1993. According to the Colorado Center for Environmental Management (CCEM), a non-profit organization formed by Colorado's Governor Romer to find solutions to environmental management problems, "this monitoring was prompted by a long-term need to better understand mine-related problems in the area and impacts across the Basin."[11] One might surmise as well that the hammer of the Clean Water Act had something to do with this monitoring.

In 1991, however, the slow grind of the bureaucratic machinery surrounding the Clean Water intersected with second set of events. The Sunnyside Gold Mine, the largest remaining gold mine in the San Juans, ceased operations in 1991. Echo Bay Mining Corporation had bought the Sunnyside Mine in 1986. After five years of losses the mine owners closed the operation. Gold production had never reached expected levels, and with the continued low price of gold the company decided to cut its losses.[12]

Now, as part of its closure Sunnyside Gold was required to submit a reclamation plan to the Colorado Division of Minerals and Geology. This plan called for the removal of mining buildings, the consolidation and revegetation of waste rock and mine tailings, and the diversion of surface water flowing from the mine. The Colorado Division of Minerals and Geology approved the overall reclamation plan. But Sunnyside also needed a release from its NPDES permit from the Department of Public Health and Environment for the water that was leaving their site. The flow from the mine, which averaged 2000 gallons per minute (gpm), was only mildly acidic, but it did contain high levels of zinc and iron. Prior to the Clean Water Act the water had flowed directly into Cement Creek. In the 1970s, however, the mining operator built a water treatment plant that operated under a NPDES water discharge permit, the latter being issued by CDPHE. By the early 1990s Sunnyside Gold was spending approximately $500,000 dollars a year to run this plant, cleansing the mine water before it flowed into Cement Creek and eventually the Animas.[13]

As part of its mine closure plan Sunnyside proposed to plug the mine entrance (known as the "American Tunnel") and discontinue treating the water coming from the mine. Sunnyside's claim was that the mine works would fill with water; in a short amount of time the water within the mine would reach a chemical equilibrium similar to natural background conditions. The output from the mine portal would thus end, and any new springs that might appear in the area would have the pH and metal loading natural to the region. Sunnyside would achieve its goal—financial closure to its involvement at the site—with no negative effects upon the Animas drainage.

The Colorado Department of Public Health and Environment objected to the plan on two grounds. First, the treated water entering Cement Creek from the mine actually improved the water quality of the creek. To plug the portal would therefore have the net effect of degrading the water quality of Cement Creek. Second, the CDPHE had doubts about Sunnyside's claim that the waters within the mine, once filled, would eventually equilibrate to natural background conditions. The natural conditions of the mountain had clearly been irretrievably changed: the mountain had been hollowed out, and fractured by continual dynamiting over the years. Furthermore, the production of acid drainage is greatly accelerated by exposing rocks to a mixture of water and air. Driving hundreds of adits and tunnels into the mountain had created the perfect combination of air and water for the production of acid drainage. Sunnyside Gold's plan was to keep the site entirely wet, thus turning off the production of excess acid drainage. The CDPHE, however, was far from sure that the flooded mine would equilibrate to natural background. It therefore refused to let Sunnyside out from under its water discharge permit obligations, claiming that any new seeps that developed would be subject to NPDES obligations as permit discharges. Sunnyside's response was to sue in state court, claiming they did not need any such permit.

Sunnyside and the State of Colorado reached an out of court settlement in May of 1996. As part of this agreement Sunnyside signed a Consent Decree which stated that they would clean up sites in the San Juans equaling the total amount of the discharge coming from their mine.

We will return to the issues raised by this Consent Decree. First, however, note how the terms of the debate have shifted. The reasonableness of Sunnyside's proposal now turns not only on the details and the interpretation of the Clean Water Act, but also upon our understanding of the chemistry, hydrology, and geology of the region. Here two disciplines meet—public policy and the earth sciences. Let us, then, turn from the Clean Water Act to the situation on the ground—and beneath it.

Science as Hermeneutics

Approaching the San Juan Mountains from the south, driving up the Animas River valley past the towns of Durango and Hermosa, one passes beneath massive cliffs of red and buff-colored sedimentary strata that tilt upward to the north. Coming to the San Juans from the north one faces a similar scene, but now the layers slant upward to the south. It is as if a titanic force had pushed the sedimentary beds from below, tilting the beds until it burst through at what is now the center of the San Juans.

This is approximately the account that geologists offer of the San Juan Mountains. The sloping sedimentary strata all point toward the center of the mountains, where one finds abundant evidence of volcanic activity: lava, welded ash flows, mineralization, and deeply faulted structures. Sometime in the mid-Tertiary--around 30 or 35 million years ago—what is now southwest Colorado became a volcanic landscape. The source of the lava and ash was probably a batholith, a huge mass of subterranean magma that was also the origin of the minerals that someday would interest the miners. The volcanism continued over the next 10 million years, consisting of a long series of explosions, many of which dwarfed Mount St. Helen's and Pinatubo.

Silverton itself lies in the midst of the San Juan volcanic field, at the edge of the Silverton caldera (see map 3). A caldera is a volcano that has collapsed upon itself: after the explosive venting of the lava and ash the sides of the volcano fall inward, leaving a concave depression. While the interpretation of the area is complex, there is evidence of multiple periods of volcanic activity, and multiple, overlapping calderas in the region. One estimate puts the number at fifteen. It is clear, however, that the collapsed volcanic complex is the source of the heavy metals in the region. One finds a series of faults running along what is interpreted as the rim of the caldera, and another set of radial faults that issue from what appears to be the volcano's center. These fractures later served as the plumbing system for the upward movement of mineral-laden fluids. Sometime after subsequent to the period of volcanism metal ores precipitated in veins along these fractures.

Seeing the caldera requires an educated eye. The volcanic lavas and welded tuffs (a welded tuff consists of superheated volcanic ash that fell like snow and bonded) are clear enough. So are the signs of mineralization in the area: Red Mountain north of the town of Silverton gains its name from the oxidized orange and red stains covering its sides. But the geography has been transformed since the mid-Tertiary. The topography has become inverted: what was once high is now low, and vice versa. The fractured outside edge of the caldera defined an area of weakness which not only allowed the passage of hydrothermal fluids from below, but also snowmelt and rainwater from above. Erosion attacked the ring faults—especially during the last two million years of glacial conditions in the area. Thousands of feet of rock were removed, and the fault zones came to define the paths of the river courses. Valleys were cut along the edge of the caldera at the same time as the area was elevated through regional uplift. Today the river courses of Mineral Creek and the Animas River define the south and west sides of the caldera's edge.

One point to draw from this—beyond the intrinsic interest of such a stupendous series of events, of a landscape shaped by both fire and ice—is that the region is a naturally mineralized area that was subject to acid drainage and heavy metal contamination long before the appearance of humans. After all, it was these naturally-occurring conditions that drew the miners to the region in the first place. Acid *mine* drainage, then, is but an accelerated form of the natural processes of the acid *rock* drainage intrinsic to the area. Acid rock drainage results from natural weathering processes and the regional geology.

On the other hand, several hundred adits and tunnels have been driven into the rock of the Silverton caldera. The mountains have been further fracturing through the use of dynamite. Finally, by dumping mine tailings and waste out on the surface the overall surface area exposed to air and water has been greatly increased. In such circumstances separating natural background conditions from what was caused by human activity becomes a difficult and contentious question.

The production of acid drainage is complex process involving chemistry and biology as well as geology. Exposure of the sulfur-rich rocks to air and water causes the sulfide minerals (e.g., pyrite, galena, and sphalerite) to oxidize. Take the example of pyrite (FeS_2), commonly known as Fool's Gold. Rain water, snowmelt, and exposure to air break the iron sulfate compound into its constituent parts, ferrous iron and sulfur at a relatively slow rate. The sulfate ions react with the water to produce sulfuric acid. However, this natural chemical reaction is not in itself sufficiently energetic to produce significant amounts of acid drainage. The reaction is massively accelerated by the biological activity of the sulfur-oxidizing bacteria in the genus *Thiobacilli*. *Thiobacilli* are chemolithotropes: they "eat" rocks. *Thiobacilli* rapidly increases the rate of oxidation, resulting in an explosive expansion in the amount of acid drainage.

pH is a index of acidity measured on a logarithmic skill: going down the scale, each number represents a tenfold increase in the amount of acidity. The pH in streams of the upper Animas drops as low as 2 and 3 (lower than the pH of vinegar; rainwater is approximately 5.6, fish die in pH below 5). It is this low pH that pulls the heavy metals out of the rocks, causing the high concentrations of metals in solution in the water and leading to the fish kills. The striking bright orange-red stains coating the sediments and the rocks in streambeds can be a sign of either the buffering of the pH, causing the metals to precipitate out of solution (and thus a sign of the cleansing of the stream), or that the river is so saturated with metals that they precipitate out even at a high pH.

Distinguishing between natural and anthropogenic acid drainage is a tricky process. Of course, an old mine works, timbers askew and a thick rivulet of red gunk issuing from the portal, is a poster child for acid mine runoff. But it remains an open question how much of that discharge has been generated through mining, and how much is simply the concentration in one location of natural runoff that previously found its way to the surface through unknown springs across the mountain. The geologist offers an educated guess: in this case it would probably be that the vast majority of the drainage is human-caused. But conditions are sufficiently open to differing interpretations to give rise to interminable debates.

Hydrologist Win Wright of the US Geological Survey has worked extensively on the question of distinguishing between natural and anthropogenic acid drainage. In one drainage, the Middle Fork of Mineral Creek, Wright found 73 springs and 17 mines.[14] Of the mine sites, seven had water coming from the portal. Throughout the basin Wright faced the challenge of trying to identify whether seemingly "natural" seeps were truly natural, or whether they were the surface expression of mining activity further upslope. Sometimes the evidence was conclusive; but often Wright was faced with trying to map the faults in an area to help define the possible relation between an old mine site and a seemingly natural spring.

The fundamentally interpretive nature of such phenomena is made apparent by Wright's choice of the Red Chemotroph Spring as his picture of a natural mineral-rich seep (see photo, opposite). I was present the day this picture was taken. As Win talked to our group, describing this as an example of a natural spring, I wandered upslope and found two one-inch diameter pipes snaking down the mountain. The pipes stopped some fifty feet from the spring, there was nothing coming from the pipes, nor was there a clear sign of past discharge. I did not trace the pipes to their starting point up the hill. Instead, returning to the group, I asked Win about the pipes. He knew of their existence, but claimed that they had no influence upon the existence or development of Red Chemotroph Spring.

The life of the field geologist is filled with situations such as this—judgment calls made on the basis of one's education, partial data, and years spent in the field. Most of the evidence surrounding acid mine drainage involves such judgment calls. For instance, the pH and mineral content of a stream can vary with both time of day and season. On a warm summer day a small rivulet will be flushed with snowmelt by noon, a fact that will itself vary according to whether the winter was one of normal snowfall or not. Readings in early June will differ from July or September as the snowpack declines. Readings by two people on the same day, at the same time, in two different valleys, can still vary because of different surface or weather conditions.

Even the instruments measuring pH and conductivity can be thrown off by the lack of ions present in the snowmelt. Measuring pH—the amount of protons in a solution—requires a basic level of background conductivity. But rain and snow is typically low in anions and cations. Unless the field worker adds potassium chloride to the sample the result will be systematically in error. Correcting for conditions such as these requires a nuanced sense of one's subject matter, what the biologist Michael Polanyi called "personal knowledge." Aristotle noted the existence of a similar intellectual skill when he spoke of the role of *phronesis* or good judgment in thinking.[15]

When brought up, field geologists are often apologetic about the fundamentally interpretive nature of their research. After all, "professional judgment" sounds suspiciously like a "subjectivity." Such an appeal flies in the face of our culture's image of science, which is supposed to offer an authoritative basis for policy decisions. Field sciences such as botany, ecology, hydrology, and geology are thus typically seen as poor kin to laboratory sciences, which promise reliable (that is, repeatable) results. What goes unappreciated are the hermeneutic skills that field practitioners have developed—the ability to make sense of the hints contained in the rocks or the water. Hermeneutics, or interpretation theory, is a type of reasoning that relies as much upon experience and discernment rather as calculative ability.

I will return to this question—the nature of field reasoning, and its supposed inferiority to the laboratory sciences—in later chapters. The point I wish to emphasize here is this. Science is typically brought into political controversies because it is seen as the means of resolving debates. The conflict between Sunnyside Gold and the State of Colorado was going to be mediated on the basis of "sound science." Instead, the science has itself become a bone of considerable contention.

Before returning to these questions, however, there is one more element of the acid mine drainage controversy that requires development. For it is arguable that this entire argument has gone off track. What difference does it make whether the streams of the upper Animas are polluted by naturally occurring springs and seeps, or by the results of mining? A pH of 3.2 is a pH of 3.2 in any case. This question is seldom faced head-on, but its presence hovers about the topic like a swamp gas. To address it takes us beyond the discourses of politics and science to subjects that are rarely taken seriously in our environmental debates.

The Metaphysics of Acid Mine Drainage

Assume for the moment that the scientific research done to date is correct: that a great deal—quite possibly more than half—of the acid drainage and heavy metal contamination in the rivers is the result of natural geologic conditions, and thus predates any mining activity. Of course, as was noted above, identifying which streams are naturally polluted or not is a highly interpretive exercise. But set this question to one side, and consider: if a stream is found to be naturally lifeless, do we leave it be, and clean only those areas that have been rendered sterile through human action? What if it is established that a human-acidified stream is much more expensive or harder to clean (because of accessibility, or local geology) than an equally "polluted" naturally acidified stream? By what reasoning would we spend the extra money to clean up the human-caused damage?

These are peculiar questions, leading to points that are abstract, even metaphysical in nature. But they are also immediate and practical, in that they express a concern and an intuition deeply felt by many. Followed out, such questions draw us into provinces seldom seriously explored within contemporary political debates. They ask us to carefully consider our motivations for cleansing these streams. Are we doing it because of human health and safety (i.e., questions of water quality, to protect our drinking water)? In order to create habitats for fish and invertebrates, even if they were not native to the area? To increase the tourist trade through the expansion of trout fisheries? Or—as was once suggested in my presence—because the tailings piles and orange stream courses "look like sin"?

These questions approach us from two sides. First, as we have seen, the appeal to science as sufficient means for the resolution of environmental problems does not work. Science helps us draw parameters around a problem, or outline possible scenarios for action. But science only rarely can substitute for political deliberation. Second, our responses to nature cannot be encompassed by the calculus of science and economics. A lifeless, foul-smelling river excites our disgust, and so we turn to the chemist and the public health official to define our outrage. The cutting down of old growth forests has a severe impact upon fisheries downstream, and we ask the ecologist and economist to quantify our losses. But the paucity of this approach becomes apparent once we examine our own reactions to environmental destruction. We are sickened by a fouled stream even if our water supply is located elsewhere; and the conversion of an ancient forest into a redwood deck evokes in many a sense of sacrilege.

In the upper Animas, human health seems to be a minor issue. The town of Silverton draws its drinking water from the Bear Creek watershed, which was purposely placed off-limits to mining in the 19th century. By the time the river reaches larger towns downstream, such as Durango and Farmington, the flow has been sufficiently diluted to not be a concern.[16] Neither have epidemiological studies of the Silverton area turned up any unusual amounts of illness.[17] And if the primary concern is to improve the economy, either through improving the scenery or the fishing, then it would be much more economical to simply write the citizens of Silverton a check.

No, something more obscure and fundamental is going on here. There is on the part of many an intuition that there has been something wrong with the way we've behaved. We have mistreated the natural world, and we are under some type of obligation to correct our mistakes.

Is it possible to make sense of this intuition? We are all aware of the criticisms leveled at claims like these. They are rejected as subjective, and unnecessarily mystifying. Moreover, they are often seen as politically dishonest—matters of personal preference masquerading as something more, that lay claim to an illegitimate place within political discourse. In other words, such intuitions have no standing in public debate. They are ejected on epistemological grounds: they do not pass the reality test of being "real" or objective.

This response, however, presupposes the existence of a higher standard of certainty and proof that one is able to depend upon. It is the contrast with the purported clarity and objectivity of scientific knowledge that renders these other claims to knowledge and reality otiose.

The status of scientific knowledge thus becomes central to the evaluation of the acid mine drainage controversy. In recent years this question has been the subject of a contentious debate, the "science wars," where the defenders of the objectivity of the scientific method do battle with those who seek to demonstrate that science is just as subjective as politics, aesthetics, and religion. These points will be addressed at some length below, but to preview: my argument will be Aristotelian in nature, defending a position that sees science as less objective, and aesthetics, metaphysics, and theology as less subjective, than is commonly thought. The type of reasoning practiced by field scientists will be offered as a model for the nature and limits of human reasoning, both scientific and otherwise.

I will close this chapter with an account which lends a measure of plausibility to the intuition described above. I do so in the hope that we can open up a space where the topics of aesthetics, metaphysics, and theology can once again become part of our public conversation.

In the essay *Faking Nature* Robert Elliot explores what he calls the ontological aspects of our concern with nature.[18] What, if anything, is at stake if a mining company can completely restore an area after the mining is completed, to the point that no one could tell the difference afterward? Of course, many will doubt the premise—that it is possible to put an ecosystem or the natural features of the land back together again. But to argue on these grounds is to make the preservation of nature dependent upon technological insufficiency. If (or as some will claim, impressed by the dynamic nature of technology, when) we become able to reconstruct ecosystems, this objection to the plans of the mining or timber company become irrelevant. One sees the same type of argument when it is suggested that the rain forest should be preserved because of the medicines that have been developed from tropical plants; or because of the incalculable or not-reproducible ecosystem services the forest provides. These arguments also fall to the side when the medicines are able to be created in the lab, or we improve our understanding and technological prowess in reconstructing or mimicking ecosystem services.

The virtue of Elliot's argument is this: it highlights the fact that our concerns are at root metaphysical or ontological in nature. Elliot offers a series of examples that show that it is often the origin or ontological status of a thing, rather than its particular physical constitution, that matters most to us. Imagine a beautiful, hand-crafted knife received as a gift. One cherishes the knife, and displays it is prominently displayed in one's home. It is then discovered that the knife is made from the bone of a person killed expressly for the purpose of making the knife. Nothing has changed in terms of the knife's chemical or physical characteristics. Nevertheless, its nature has been irretrievably changed. The knife is now a source of repulsion rather than delight.

Consider another example. Stand in the valley carved by the South Fort of Mineral Creek west of Silverton, and look east to the massive form of Red Mountain rising against the sky. The peak makes a stunning impression, not only through its height and pyramidal shape, but also because its rocky slopes and peak are a range of yellows, oranges, and reds that make a brilliant contrast with the evergreens covering its flanks. But what if it is discovered that the colors come, not from nature, but from the leakage from mines at the mountain crest? Doesn't the meaning of the colors change, and our reaction as well?

Elliot notes that to acknowledge the value of natural things does not commit oneself to affirming *all* natural things. One may grant that sickness and disease are natural, while still combating them. Neither does the point require an absolutely pristine sense of the natural. One may grant that things are more or less natural: indeed, today it is doubtful if anything in nature is unmodified by human activity in one way or another. His point is simply that, within certain limits, the naturalness of a thing provides us with a reason for protecting it. Or to reframe the point, the *meta*-physical status of an object counts as well as its physical characteristics. Metaphysics has long suffered from bad press, both within philosophy, and in the culture at large. Without revisiting all of those battles, let us note in conclusion that metaphysics simply claims that the nature of reality cannot be entirely encompassed by those things measurable by science.

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[1] Cf. Greg Easterbrook, *A Moment on the Earth* (

[2] citing?

[3] This estimate comes from the Mineral Policy Center, which can be found in their book, Golden Dreams, *Poisoned Streams (Mineral Policy Center: Washington, D.C.)*, 1997.

[4] "Navigable" is here meant in the common, rather than the technical sense of th Clean Water Act (see below).

[5] On Colorado mining history, see Duane Smith, . A good general introduction to the San Juans is *The Western San Juan Mountains: their Geology, Ecology, and Human History*, Robert Blair, ed (University of Colorado Press, Niwot, Colorado), 1996.

[6] See *Federal Environmental Law: The User's Guide*, Moya, Olga L, and Fono, Andrew L. (West Publishing, St. Paul, MN), 1997. p. 288.

[7] Under the Clean Water Act, navigable is defined as including almost any body of water, with the exception of groundwater, including potholes, intermittant streams, dry washes, canals, and wetlands.

[8] citing

[9] In general, the EPA's exercise of its authority has become increasingly subtle over time. The Agency now works with states on the front-end of rule-makings, rather than just rejecting them months or years later.

[10] Simon e-mail

[11] CCEM

[12] Chris Hays, and Carol Russell's talks

[13] Interview with Chris Hays, February 11, 1999.

[14] Wright, W.G., "Natural and Mining-Related Sources of Dissolved Minerals During Low Flow in the Upper Animas River Basin," Southwestern Colorado, USGS Fact Sheet FS 148-97, October 1997.

[15] Michael Polanyi, *Personal Knowledge* (; Aristotle, Nicomachean Ethics, Book 6

[16] The drinking water of Durango comes from another watershed, that of the Florida river.

[17] Citing here??

[18] Robert Elliot, 'Faking Nature', *Inquiry*, Vol. 25, no. 1 (March, 1982), pp. 81-93.

EPA United States Environmental Protection Agency

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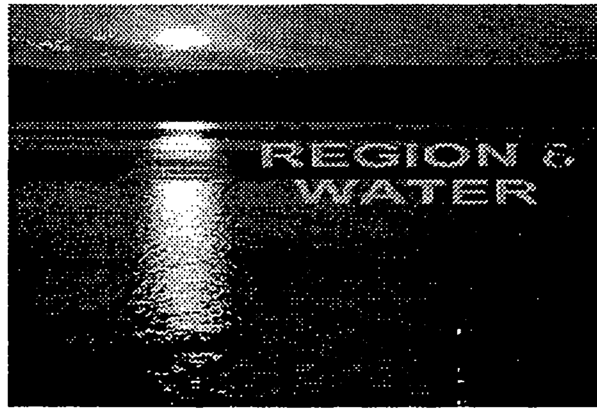

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Date Posted: April???, 1998

The Problem

The effects of past hardrock and coal mining on the Nation's ecosystems have not been fully documented. While estimates vary, it is generally recognized that there are some 200,000 to 500,000 inactive and abandoned hardrock mines nationwide. Mining can affect both surface and groundwater. Directly, by disturbing the aquifer, and indirectly, through runoff, mining can impact nearby water bodies and can cause serious water pollution and public health problems. A watershed approach to solving these problems fosters communication and cooperation among the various stakeholders such as Federal agencies, states, tribes, local government, industry, and environmental groups. Improperly managed, mining activities can increase sedimentation, release toxins and leaching solutions from impoundments, generate acids from waste rock and pit walls, and foster air deposition of dust and tailings In 1995, the Environmental Protection Agency (EPA) Region III found that 5,100 miles of streams were adversely affected by acid mine drainage. Much of this can be attributed to abandoned coal mines. In contrast to past mining activities, modern mining operations are generally properly designed, well operated and regulated.

What is the Clean Water State Revolving Fund (CWSRF)

The 51 CWSRF programs work like banks (each state and Puerto Rico has one). Federal and state contributions are used to capitalize or set-up the programs. These assets (in excess of $27 billion) are used to make low-interest loans for important water quality projects. The CWSRF programs currently issue approximately $3 billion in loans annually. Funds are repaid to the CWSRF's over terms as long as twenty years. Repaid funds are recycled to fund other water quality projects. The CWSRF can also provide loan guarantees, bond insurance, and refinancing of existing debt.

What's in it For You?

In considering the impacts of mining on the environment, EPA expects the CWSRF become a significant source of funding for nonpoint source projects, such as mining. Certain mining sites that contribute to water quality impairment could benefit from this huge financial resource. Loans are issued at below market rates (0% to less than market), offering borrowers significant savings over the life of the loan.

Sources of Loan Repayment

Though finding a source of repayment may prove challenging, it does not have to be unnecessarily so. Many users of the CWSRF have demonstrated a high degree of creativity in identifying sources of loan repayment. The source of repayment need not come from the project itself. Some possibilities include

- Fees paid by developers on other lands
- Recreational fees (fishing licenses, park entrance fees)
- Stormwater management fees
- Wastewater user charges
- Donations or dues made to nonprofit groups and associations

The CWSRF will invest 10% of its funds on polluted runoff projects by 2001.
--Clean Water Action Plan

Restrictions

Currently, under the National Pollutant Discharge and Elimination System (NPDES), operating hardrock mines are regulated as point sources. Discharges from openings in inactive or abandoned hard rock mines are also considered as point sources under the NPDES. Since 1977, coal mines have been regulated as point sources under provisions of the Surface Mining Control and Reclamation Act (SMCRA). Hardrock mines are not eligible for SMCRA funds unless all coal mines within the state have been reclaimed. Point sources are not eligible for CWSRF loans unless they are publicly owned. **However, downstream areas affected by these discharges such as stream beds or flood plains are eligible for CWSRF assistance**. Cleanup of these areas will only be effective when the contributing upstream point source discharges are brought under control

Eligible Projects

Potential projects include the removal of tailings from stream beds and flood plains, and the restoration of aquatic or secondary impacts caused by mining activities. (Jen Sachar to provide additional items)

The following are examples of mining projects, that while funded under the Clean Water Act as nonpoint source grants, would be eligible for loans from the CWSRF.

The Colorado Division of Minerals and Geology and an operating mining company are cooperating to reduce the drainage of heavy metals into a tributary of Clear Creek. The processing of mine wastes for a heap leaching operation provides an opportunity for the mining company to do site reclamation and drainage stabilization. The $52,000 Nonpoint Source grant will be used for grading and capping mine tailings, the placement of check dams and other stabilization techniques.

The Westmoreland County Conservation District, in cooperation with the Western Pennsylvania Coalition for Abandoned Mine Reclamation, used a NPS grant to complete acid mine drainage remediation work to reduce contamination from an abandoned coal mining site.

The Colorado Division of Minerals and Geology , in association with the Animas Watershed initiative, (which includes local citizens, agencies, mining interests, and state and Federal land managers), is conducting a project to improve water quality by removing mine wastes from drainage areas and neutralizing acid mine water using limestone backfill of the mine entrance. The mine waste area will then be regraded and revegetated.

A $89,000 grant with the Colorado San Juan Resource Conservation and Development organization will demonstrate the use of hydrologic controls and revegetation to reduce heavy metal contamination of the Animas River watershed.

A $47,000 NPS grant to an earthmoving company is being used to remove mill tailings and mine waste from the Kerber Creek, Colorado stream channel and dispose of them in a nearby waste repository. After the mine waste and tailings have been removed from the creek, the banks will be stabilized and revegetated.

Since 1989 the CWSRF program has funded 1,100 projects, investing more than $830 million to clean up polluted runoff.

I'm Interested--What Next?

Since the CWSRF is managed largely by the states, project funding may vary according to the priorities within each state. Projects become eligible for funding by being included in the state Nonpoint Source Management Plan, state Priority List, or part of a National Estuary Program Comprehensive Conservation and Management Plan. For more information about the CWSRF program in your state and to learn more about applying for loans and other financial assistance, contact the appropriate EPA Regional CWSRF coordinator. They will be able to discuss the general status of CWSRF uses in your state and provide a contact person in your state's CWSRF program.

Challenges Ahead

We need to make better use of the CWSRF for important mining water quality projects. Greater understanding of the tremendous buying power and advantages of SRF loans should dramatically boost their use. EPA has been encouraging the states to open their CWSRF's to the widest variety of water quality projects, while still addressing their highest priority projects. Those interested in cleaning up mine sites must seek out their CWSRF program, gain an understanding of how their state program works, and participate in the annual process that determines which projects are funded.

Clean Water
State Revolving Fund

For more information on the Clean Water State Revolving Fund Program contact:

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